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Description

The present invention relates to an optical pickup device used in CD (compact disk) player and an optical video disk device.

i) Outline of an optical pickup device

As to an optical pickup device used in a CD player or the like, a technique of utilizing a diffracting element (hologram element) for reducing the number of parts comprising the optics has hitherto been developed.

An optical pickup device of this kind is shown in Figs. 10 and 11.

As shown in Fig. 10, a laser beam emitted from a light emitting element 11 first passes through a diffracting element 12. A 0th-order diffracted ray having passed through diffracting element 12 is focused on a disk 15 through a collimator lens 13 and an objective lens 14.

Then, a reflected ray from this disk 15 passes the diffracting element 12 in the opposite direction through the objective lens 14 and the collimator lens 13. The diffracting element 12 is divided into diffraction regions 12a, 12b being different in diffraction angle by a parting line along a track direction, as shown in Fig. 10. Hence, a 1st-order diffracted ray diffracted in the diffraction region 12a is focused on light receiving elements 16a, 16b. On the other hand, a 1st-order ray diffracted in the diffraction region 12b is focused on light receiving elements 16c, 16d.

Individual output signals Sa-Sd from these light receiving elements 16a-16d are respectively converted into a focusing error signal FE, a tracking error signal TE and a reproduced information signal RF by means of an arithmetic circuit shown in Fig. 11. The arithmetic operation represented by the following formula, according to a kind of knife edge method, is performed on the output signals Sa-Sd using addition circuits 17, 18 and a subtraction circuit 19 whereby the focusing error signal FE is detectable.

$$FE = (Sb + Sc) - (Sa + Sd)$$

The arithmetic operation represented by the following formula, according to a push-pull method, is performed on the output signals Sa-Sd using addition circuits 20, 21 and a subtraction circuit 22 whereby the tracking error signal TE is detectable.

$$TE = (Sc + Sd) - (Sa + Sb)$$

The reproduced information signal RF is detectable by adding all the output signals Sa-Sd, using the addition circuits 20, 21 and the other addition circuit 23, according to the following formula.

$$RF = Sa + Sb + Sc + Sd$$

ii) Tilting mechanism of an optical pickup device

The aforementioned optical pickup device, however, has its disk 15, for instance, warped so that, if an incident optical beam does not hit the disk surface vertically, it results in coma-aberration occurring in a beam spot on the disk surface, thereby being likely to give cause for cross-talk from the adjacent tracks. With such an optical pickup device, therefore, it is necessary to provide a tilting mechanism for tilt angle adjustment according to an inclination of the disk surface for compensation thereof so that the optical beam is always incident upon the surface of the disk 15 vertically, even if the disk 15 is warped.

In the case that a tilt angle is to be adjusted by means of the tilting mechanism, it has hitherto been a usual practice to provide the tip of the optical pickup device with a tilt sensor 24 as shown in Figs. 12(a) and (b) whereby the tilt of the disk surface has been detected.

This tilt sensor 24 is made up of a light emitting element 25 and a pair of light receiving elements 26a, 26b. The light emitting element 25 is so arranged that an irradiating ray therefrom is emitted toward the disk 15, while the light receiving elements 26a, 26b are disposed on both sides of the light emitting element 25 in a radial direction with regard to the disk 15.

In this arrangement, as shown in Fig. 12(a), when the disk 15 is warped upward as being radially outward, an irradiating ray from the light emitting element 25 is reflected by the disk 15 outward and the quantity of received ray of the outer light receiving element 26b is larger than that of the inner light receiving element 26a. Also, as shown in Fig. 12(b), when the disk 15 is warped downward as being radially outward, an irradiating ray from the light emitting element 25 is reflected by the disk 15 inward so that the quantity of received ray of the inner light receiving element 26a is larger than that of the outer light receiving element 26b. Hence, when the outputs from the light receiving elements 26a, 26b are entered into a subtraction circuit 27, shown in Fig. 13, a tilt error signal in accordance with an inclination of the disk surface is obtainable.

However, providing the tilt sensor 24 independent of the optical pickup device as mentioned above means increasing the number of parts of the device. Also, it is necessary to do initial adjustments so that the tilt error signal released from the subtraction circuit 27 with respect to a warp-free

and flat reference disk becomes "0". This results in an increased assembly man-hours of the product.

Thus, a convention optical pickup device has to be provided with an independent tilt sensor 24 for adjustment of tilt angle, and this means an increased number of parts and necessity of initial adjustment, and these are naturally accompanied by cost increase of the product.

From EP-A-0 351 953, which is state of the art under Article 54(3) EPC for the designated states DE, GB, there is known an optical head in which a tilt error signal is generated from sub-beams of light derived from the main reproduction light beam. In this optical head the sub-beams reflected from the optical disk are directed onto detection elements by a beam splitter.

EP-A-0 228 620 teaches the use of sub-beams for generating focusing and tracking error signals. A diffraction element is used to generate the sub-beams and to direct the reflected sub-beam onto detection elements.

It is an object of the present invention to provide an optical pickup device designed to be capable of detecting a tilt error caused by warping et cetera of a recording medium.

Another object of the present invention is to provide an optical pickup device designed to be capable of detecting a tilt error caused by warping et cetera of a recording medium without providing a separate tilt sensor so as to prevent increase of the manufacturing cost due to an increased number of constituent parts and increase of the assembly man-hours for initial adjustment.

The invention provides an optical pickup device for focusing an irradiating ray from a light emitting element on a recording medium and letting a reflected ray reflected by this recording medium focus on a light receiving element, the device comprising: a diffracting element disposed before said light emitting element and said light receiving element; at least a first diffraction region included in said diffracting element for separating said irradiating ray from said light emitting element into a main beam and sub-beams shifted from said main beam in a direction perpendicular to a track direction of a track of said recording medium where said main beam is focused: a second diffraction region included in said diffracting element for directing a reflected ray of said main beam reflected from said recording medium onto a main light receiving element and directing reflected rays of said sub-beams onto sub-light receiving elements; and an arithmetic circuit for detecting a tilt error signal showing the focusing condition of said sub-beams according to the output of said sub-light receiving elements.

In the aforementioned construction, the irradiating ray emitted from the light emitting element passes through the diffracting element. Main beams which are among the diffracted rays having passed through the diffracting element are focused on the recording medium (The aforesaid rays include the 0th-order diffracted rays. The same shall apply hereinafter). These main beams may be normally any of all 0th-order diffracted rays which have respectively passed through the diffraction regions. In order to ensure against the difference in quantity of light according to the respective diffraction regions where the diffracted rays have passed through, it is preferable to arrange that the 0th-order diffraction efficiencies in the individual regions are as equal as possible. These main beams are for reproducing the information stored in the recording medium, and at the same time are for detecting a focusing error signal by the knife edge method of the astigmatism method or the like. These main beams may also be applicable for detection of a tracking error signal by the push-pull method et cetera.

Also, of the diffracted rays having passed the first diffraction region of the diffracting element, the diffracted rays other than the aforementioned main beams constitute sub-beams and are focused on a position shifted from the main beam in a direction perpendicular to the track direction of the track where the main beam is irradiated on the recording medium. When a 0th-order diffracted ray is adopted as a main beam, it is proper to use ± 1st-order diffracted rays as these sub-beams.

When the tracking error signal is detected by the 3-spot method, it is also possible to provide a third diffraction region in the diffraction element, in which tracking error detection sub-beams shifted back and forth from the main beam in a track direction of the track where the main beams are irradiated are separated.

The reflected rays of the main beams reflected from the recording medium pass through the second diffraction region and the diffracted rays therefrom are irradiated onto a main light receiving element. The reflected rays of the sub-beams pass through this second diffraction region and the diffracted rays are caused to be irradiated onto a second light receiving element. Since the optical axes of these reflected rays are inclined to each other, the same diffracted ray in the second diffraction region can be utilized. When the main beams consist of the 0th-order diffracted rays from the diffracting element, it means that as these reflected rays the diffracted rays other than the 0th-order diffracted rays are utilized. In this case, if the second diffraction region is provided with a blaze property so that a luminous intensity of, for instance, the +1st-order diffracted ray alone is raised, a sufficient sensitivity may be secured even when only one diffracted ray is to be utilized.

The main light receiving element is divided into 2 or 4 light receiving regions when a focusing error signal is to be detected by the knife edge method or the astigmatism method. A reproduced information signal can be obtained by adding all of the respective outputs from these light receiving regions. A focusing error signal is obtainable by performing arithmetic operations on the outputs from these light receiving regions according to the respective formulae. The same performance applies to the case where a tracking error signal is detected by the push-pull method. When a tracking error signal is to be detected by the 3-spot method, the aforementioned tracking error detection sub-beams having passed through the second diffraction region are arranged to be focused onto tracking error detection sub-light receiving elements disposed before and after the main light receiving element along a track direction.

The sub-light receiving elements are normally disposed before and after the main light receiving element along a direction perpendicular to the track direction. When the knife edge method is employed, a light receiving area of the sub-light receiving element is divided by a parting line along the border line of the second diffraction region. Hence, if the difference between outputs from these light receiving regions is determined, it is possible to detect a focusing condition of the sub-beams. This focusing condition of the sub-beams is indicating an inclination in a direction perpendicular to the track direction of the recording medium when the main-beams are in focus on the recording medium.

Hence, in the case of an optical disk, for instance, an inclination in a radial direction is caused by warp and the like, and it is possible to obtain a tilt error signal. This tilt error signal is sent to a tilting mechanism whereby through adjustment of the tilt angle of the optical pickup device the main beams are always so adjusted to be focused on the recording medium vertically.

When the sub-beams are composed of two beams on both sides of the main beams as in the case where, for instance, ± 1st-order diffracted rays of the aforementioned first diffraction region are utilized as sub-beams the outputs from the respective light receiving regions of the two sub-light receiving elements disposed in two positions are added alternately and then the difference between these results is determined, whereby an inclination of the recording medium is detectable even when the main beam is out of focus. If the main beams should always be in focus, detection is possibly feasible by means of one sub-beam, and it is also possible to use the focusing error signal by means of the main beam instead of the other sub-beam. In this case, the first diffraction region is provided with a blaze property thereby to increase the luminous intensity of the diffracted ray as a sub-beam, whereby it is possible to ensure a sufficient detection sensitivity even with a single sub-beam.

Also, since this tilt error signal is to be detected by the focusing condition of the sub-beams, it is also possible to be detected not only by the knife edge method but also by some other focusing error signal detection means. In such a case, it is convenient to use a method of the same principle as the focusing error signal detection means and, for instance, when the astigmatism method is used, it is advisable to utilize the property of a cylindrical lens imparted to the second diffraction region for the reflected rays of the main beams. By the way, this diffracting element may further be provided with the properties of a condensing lens for condensing reflected rays and irradiating rays.

Figs. 1 through 9 show an embodiment of the present invention, of which:

Fig. 1 is a perspective view showing the construction of an optical pickup device;

Fig. 2(a) is a front view of the optical pickup device showing the optical path of an irradiated ray from a light emitting element thereof;

Fig. 2(b) is a front view of the optical pickup device showing the optical path of a reflected ray from a disk;

Fig. 3(a) is a side view of the optical pickup device showing the optical path of the irradiated ray from the light emitting element thereof;

Fig. 3(b) is a side view of the optical pickup device showing the optical path of the reflected ray from the disk;

Fig. 4 is a plan view of a diffracting element and light receiving elements;

Fig. 5 is a block diagram showing the construction of signal detection circuits;

Fig. 6 is a partial bottom view of the disk;

Fig. 7(a) is a front view showing tilt error detection sub-beams when the disk is flat;

Fig. 7(b) is another front view showing the tilt error detection sub-beams when a peripheral portion of the disk is warped upward;

Fig. 8 is a front view showing diagramatically tilt error detection sub-beams when the disk is inclined;

Fig. 9 is a plan view showing another construction of the diffracting element.

Figs. 10 through 13 are given to show a conventional example, of which:

Fig. 10 is a perspective view showing the construction of an optical pickup device using a diffracting element;

Fig. 11 is a block diagram showing the construction of signal detection circuits;

Fig. 12 shows the tilt sensor, of which Fig. 12(a) is a front view of the essential parts when the

peripheral portion of a disk is warped upward, and Fig. 12(b) is a front view of the essential parts when the peripheral portion of a disk is warped downward; and

Fig. 13 is a block diagram showing the construction of a tilt error signal detection circuit.

A preferred embodiment of the present invention is described below with reference to Figs. 1 through 9.

i) Construction of a preferred embodiment

This embodiment relates to an optical pickup device such as a CD player and the like.

As shown in Fig. 1, there are disposed before a light emitting element 1 of an optical pickup device, a diffracting element 2, a collimator lens 3 and an objective lens 4, and a laser beam emitted from this light emitting element 1 is caused as an irradiating ray to be focused on a disk 5 as a recording medium.

A diffraction area of the diffracting element 2 is divided into two regions along a radial direction of the disk 5, and on either of these two regions is formed a second diffraction region 2b. The other divided region is further divided into two regions along a track direction of the disk 5 to form a first diffraction region 2a and a third diffraction region 2c respectively.

The collimator lens 3 is a lens for making parallel irradiated rays from the light emitting element 1 having passed through the diffracting element 2. The objective lens 4 is a lens for focusing these rays on the disk 5. These lenses 3 and 4 are so designed that the irradiating rays having been reflected by the disk 5 are again led into the diffracting element 2.

On one side adjacent to the light emitting element 1 in a radial direction are disposed light receiving elements 6a-6e. These light receiving elements 6a-6e are disposed with a main light receiving element 6a at the centre, tilt error detection sub-light receiving elements 6b, 6c on the inner peripheral side and the outer peripheral side in a radial direction, and tracking error detection sub-light receiving elements 6d, 6e before and after the main light receiving element 6a along a track direction. The aforementioned reflected rays are focused on the light receiving elements 6a-6e through the diffracting element 2.

A diffraction grating is formed in the aforementioned diffraction region 2a of the diffracting element 2, as seen from Fig. 2(a), so that an irradiated ray A from the light emitting element 1 is divided into a 0th-order diffracted ray A_{0a}, and ±1st-order diffracted rays A_{+1a}, A_{-1a}, shifted before and after from 0th-order diffracted ray A_{0a} along a radial direction. The 1st-order diffracted rays A_{+1a}, A_{-1a} diffracted in the first diffraction region 2a serve as tilt error detection sub-beams A_{+1a}, A_{-1a}, for detecting the tilt of the disk 5. In this first diffraction region 2a the other diffracted rays of the irradiated ray A and all transmitting rays of reflected rays B are not utilized.

The third diffraction region 2c, as seen from Fig. 3(a), has formed therein a diffraction grating for dividing the irradiated ray A from the emitting element 1 into a 0th-order diffracted ray A_{0c} and ± 1st-order diffracted rays A_{+1c}, A_{-1c} shifted before and after from the 0th-order diffracted ray A_{0c} along a track direction. These ± 1st-order diffracted rays A_{+1c}, A_{-1c} are converted by a 3-beam method into tracking error detection sub-beams A_{+1c}, A_{-1c} for detecting the tracking error. By the way, in this third diffraction region 2c the other diffracted rays of the irradiated ray A and all transmitting rays of the reflected rays B are not utilized.

The second diffraction region 2b has formed therein a diffraction grating to be described below and in this region a 0th-order diffracted ray A_{0b} of the irradiated ray A is only utilized as shown in Fig. 3(a). The aforementioned 0th-order diffracted ray A_{0a} in the first diffraction region 2a, the 0th-order diffracted ray A_{0c} in the third diffraction region 2c and this 0th-order diffracted ray A_{0b} in the second diffraction region 2b constitute main beams A_0 for reproducing recorded information in the disk 5 as well as for detecting the focusing error. For this reason the 0th-order diffraction efficiencies in the individual regions 2a, 2b, 2c are arranged to be as equal as possible so that the luminous intensity distribution of the main beam A_0 becomes symmetric.

This second diffraction region 2b is designed wherein such a diffraction grating is formed therein so that +1st-order diffracted rays of the reflected rays B are irradiated on each light receiving elements 6a-6e. Since the reflected rays B are composed of the 0th-order diffracted rays and the ±1st-order diffracted rays in the individual diffraction regions 2a, 2b and 2c, each ray of the reflected rays B has a different optical axis. Hence, as shown in Fig. 2(b), the reflected rays B_{+1a}, B_{-1a} of the tilt error detection sub-beams A_{+1a}, A_{-1a} are irradiated on the tilt error detection sub-light receiving elements 6c, 6b respectively. Also, as shown in Fig. 3(b), the reflected rays B_{+1c}, B_{-1c} of the tracking error detection sub-beams A_{+1c}, A_{-1c} are irradiated on the tracking error detection sub-light receiving elements 6e, 6d. Further, as shown in Fig. 2(b) and Fig. 3(b), it is so arranged that the reflected rays B_0 of the main beams A_0 are irradiated on the main light receiving element 6a. By the way, any diffracted rays of the reflected rays B except +1-order diffracted rays are not utilized in this second diffraction region 2b.

The aforementioned main light receiving element 6a, as shown in Fig. 4, has its light receiving area divided into two regions along a radial direction, and it is arranged that the reflected rays B_0 of the main beams A_0 diffracted in the second diffraction region 2b are focused on the centre of this parting line. And, since this second diffraction region 2b is to divide the reflected rays B_0 along a radial direction, it is possible to detect the focusing error signal FE by determining, according to a kind of knife edge method, the difference between output signals released from both light receiving areas. Also, by adding signals released from both light receiving areas, it is possible to get the reproduced information signal RF.

Like the main light receiving element 6a, the tilt error detection sub-light receiving elements 6c, 6b, also have their light receiving areas divided into two regions along a radial direction respectively, and it is arranged so that on the center of this parting line are respectively focused the reflected rays B_{+1a}, B_{-1a} of the tilt error detection sub-beam A_{+1a}, A_{-1a} diffracted in the second diffraction region 2b. Hence, the differences of the output signals from both light receiving regions of each of the tilt error detection sub-light receiving elements 6c, 6b are determined, whereby it is possible to detect the focusing conditions on the disk 5 of the tilt error detection sub-beams A_{+1a}, A_{-1a} respectively, as in the case of the main light receiving element 6a. Further by determining the difference between them, it is possible to detect the tilt between two points on the disk 5, where the tilt error detection sub-beams A_{+1a}, A_{-1a} are irradiated, as a tilt error signal TLE.

The tracking error detection sub-light receiving elements 6e, 6d have each one light receiving area, and it is so designed that each reflected ray B_{+1c}, B_{-1c} of the tracking error detection sub-beam A_{+1c}, A_{-1c}, diffracted in the second diffraction region 2b, is focused thereon. These tracking error detection sub-beams A_{+1c}, A_{-1c} are shifted back and forth from the main beams A_0 along a track direction of the track where the main beams A_0 are focused, and besides they are slightly shifted inward and outward along a radial direction respectively. Hence, if the difference between the outputs released from both tracking error detection sub-light receiving elements 6d, 6e is determined, according to 3-beam method, it is possible to detect a tracking error signal TRE.

The outputs released from the aforementioned individual light receiving elements 6a-6e are so designed as to be entered into signal detection circuits shown in Fig. 5. These signal detection circuits are composed of one addition circuit 7 and three subtraction circuits 8-10. The aforementioned reproduced information signal RF is detectable by performing an arithmetic operation with the following formula by means of an addition circuit 7 on output signals Sa_R, Sa_L released from both light receiving regions of the main light receiving element 6a.

$$RF = Sa_R + Sa_L$$

The focusing error signal FE is detectable by performing an arithmetic operation with the following formula by means of a subtraction circuit 8 on these output signals Sa_R, Sa_L.

$$FE = Sa_R - Sa_L$$

Further, the tracking error signal TRE is detectable by performing an arithmetic operation with the following formula by means of a subtraction circuit 9 on output signals Sd, Se released from the tracking error detection sub-light receiving elements 6d, 6e.

$$TRE = Sd - Se$$

The tilt error signal TLE is detectable by alternatively adding output signals Sb_R, Sb_L and Sc_R, Sc_L released from the tilt error detection sub-light receiving elements 6b, 6c and after that subtracting by means of a subtraction circuit 10, and consequently the tilt error signal TLE is detected by performing an arithmetic operation with the following formula.

$$TLE = (Sb_R - Sb_L) - (Sc_R - Sc_L)$$

ii) Action of a preferred embodiment

The action of an optical pickup device having the aforementioned construction is described below.

An irradiated ray A from light emitting element 1 first passes through diffracting element 2. As shown in Fig. 2(a) and Fig. 3(a), 0th-order diffracted rays A_{0a}, A_{0b}, A_{0c} having passed through all diffraction regions 2a, 2b, 2c of the diffracting element 2 are focused on a disk 5 as main beams A_0. Also, as shown in Fig. 2(a), ±1st-order diffracted rays A_{+1a}, A_{-1a} diffracted in the first diffraction region 2a of the diffracting element 2 are focused, as 2-directional tilt error detection sub-beams A_{+1a}, A_{-1a}, shifted back and forth along a radial direction with respect to the main beams A_0 on the disk 5. Further, as shown in Fig. 3(a), ±1st-order diffracted rays A_{+1c},A_{-1c} diffracted in the third diffraction region of the diffracting element 2 are focused as 2-directional tracking error detection sub-beams A_{+1c}, A_{-1c}, shifted back and forth along a track direction with respect to the main beams A_0 on the disk 5.

As the result, the main beams A_0 are focused on the centre of a predetermined track 5a of the disk 5, as shown in Fig. 6. The tilt error detection sub-beams A_{+1a}, A_{-1a} are focused on positions shifted inward and outward along a radial direction with respect to main beams A_0. Further, the tracking error detection sub-beams A_{+1c}, A_{-1c} are focused on positions which are shifted back and forth in a tracking direction and slightly shifted inward and outward in a radial direction with respect to the main beams A_0.

Then individual reflected rays B reflected on the disk 5, as shown in Fig. 2(b) and Fig. 3(b), are diffracted in the second diffraction region 2b of the diffracting element 2 and the ±1st-order diffracted rays therein are focused on light receiving elements 6a-6e respectively.

Output signals Sa_R, Sa_L from a main light receiving element 6a where reflected rays B_0 of the main beams A_0 are focused are added by means of an addition circuit 7 of signal detection circuits whereby the result is released as a reproduced information signal RF. These output signals Sa_R, Sa_L are applied to a subtraction circuit 8 to be subtracted thereby whereby the result is released as an focusing error signal FE. Output signals Sd, Se from tracking error detection sub-light receiving elements 6d, 6e where reflected rays B_{+1c}, B_{-1c} of the tracking error detection sub-beams A_{+1c}, A_{-1c} are focused are applied to a subtraction circuit 9 and the subtracted value therebetween is released as a tracking error signal TRE. Output signals Sb_R, Sb_L, Sc_R and Sc_L from tilt error detection sub-light receiving elements 6b, 6c where reflected rays B_{+1a}, B_{-1a} of the tilt error detection sub-beams A_{+1a}, A_{-1a} are focused are added and then applied to a subtraction circuit 10 to be subtracted thereby and the subtracted value therebetween is released as a tilt error signal TLE.

How the tilt error signal TLE is detected by the use of the tilt error detection sub-beams A_{+1a}, A_{-1a} is described below with reference to Figs. 7 and 8.

As shown in Fig. 7(a), when the disk 5 is flat, the tilt error detection sub-beams A_{+1a}, A_{-1a} are in focus on positions shifted inward and outward along a radial direction respectively, in the condition that main beam A_0 is in focus by means of focusing servo according to the focusing error signal FE. Hence, since both tilt error detection sub-light receiving elements 6b, 6c detect focusing conditions, the tilt error signal TLE according to difference therebetween becomes "0". In this case a tilt angle of the optical pickup device is not adjusted.

However when, as shown in Fig. 7(b), the disk 5 is inclined upward as being toward the outer periphery thereof, the tilt error detection sub-beams A_{+1a}, A_{-1a} come to be in a defocused condition even when the main beam A_0 is in focus. As shown in Fig. 8 in detail, the tilt error detection sub-beam A_{+1a} is in focus behind the disk 5, while the tilt error detection sub-beam A_{-1a} is in focus not on the disk 5 but in front thereof. Therefore, the respective tilt error detection sub-light receiving elements 6b, 6c detect focusing errors in the opposite direction, whereby the tilt error signal TLE according to the difference therebetween has a polarity corresponding to the tilting direction of the disk 5 and a value proportional to the degree of tilting. In this case the tilt angle of the optical pickup device is adjusted by means of a tilting mechanism (not shown) so that the irradiated ray A is controlled to be irradiated on the disk 5 perpendicularly.

Although in this embodiment the diffracting element 2 where a diffraction area is divided into three regions is used, the diffraction element 2 may have any number of regions in the diffraction area provided that it includes at least a diffraction region for separating the tilt error detection sub-beam and another diffraction region for focusing the tilt error detection sub-beam on a predetermined tilt error detection sub-light receiving element. In Fig. 9, there is shown another construction of the diffraction element 2 where a diffraction area is divided into 6 regions. Therein a fourth diffraction region 2d for focusing the reflected ray of the main beam on a light receiving element 6f for detecting reproduced information signal is disposed between the first diffraction region 2a for separating the tilt error detection sub-beam and the third diffraction region 2c for separating the tracking error detection sub-beam. Also, the second diffraction region 2b is divided into three diffraction regions $2b_1$, $2b_2$, $2b_3$ for focusing the reflected rays of the main beam, the tilt error detection sub-beam and the tracking error detection sub-beam on the light receiving elements 6a-6e respectively.

Also, in the present embodiment, two tilt error detection sub-beams are utilized for detection by two tilt error detection sub-light receiving elements 6b, 6c for an improved detection sensitivity. It is, however, possible to utilize either of the tilt error detection sub-beam A_{+1a} or A_{-1a} and tilt error detection sub-light receiving element 6b or 6c only for detection of the tilt error signal TLE, if these beams are focused on a position which is substantially distant from a position where the main beam is focused.

Further, in this embodiment the tracking error signal TRE is detected according to the 3-beam method using two tracking error detection sub-beams A_{+1c}, A_{-1c}. In this invention, however, a method of the tracking error signal TRE is arbitrary, and it is also possible to use the push-pull method utilizing the main beam A_0.

In an optical pickup device of the present invention, as mentioned above, an irradiating ray emitted from a light emitting element is caused to focus on a recording medium, and a reflected ray reflected by this recording medium is focused on a light receiving element. Before the light emitting element and the light receiving element are disposed a diffracting element, and in this diffracting element are included at least a first diffraction region for separating the irradiating ray from the light emitting element into a main beam and sub-beams shifted from the main beam in a direction perpendicular to a track direction of a track of the recording medium where the main beam is focused, and a second diffraction region which directs a reflected ray of the main beam reflected from the recording medium on a main light receiving element and directs reflected rays of the sub-beams on sub-light receiving elements. An arithmetic circuit for detecting the tilt error signal showing the focusing condition of the sub-beams according to the output of the sub-light receiving elements is provided in the optical pickup device.

This arrangement enables detection of the tilt error signal without increasing the number of components of the optical pickup device. The initial adjustments for that, too, can be done simultaneously with that for the optics of the optical pickup device.

Hence, an optical pickup device according to the present invention does not require installation of any additional tilt sensor for detection of the tilt signal, and also enables prevention of an increase in the number of components and the increase of cost as a result of increased assembly steps and/or the required man-hours.

The above-mentioned diffracting element may also be made up of a plurality of divided diffraction regions.

The aforementioned diffraction region may be so formed that the 0th-order diffraction efficiencies of the individual diffraction regions are substantially equal to each other so that the main beam's distribution of the luminous intensity is symmetrical.

The aforementioned diffracting element may also comprise a region other than the second diffraction region, which other region is divided into said first diffraction region and a third diffraction region.

The aforementioned first diffraction region may also comprise a diffraction grating for separating the irradiating ray from the light emitting element into a 0th-order diffracted ray and ± 1st-order diffracted rays.

The aforementioned third diffraction region may comprise a diffraction grating for separating the irradiating ray from the light emitting element into a 0th-order diffracted ray and ± 1st-order diffracted rays shifted back and forth from the 0th-order ray along a track direction on a recording medium.

The aforementioned second diffraction region may be provided with the properties of a cylindrical lens.

The aforementioned optical pickup device may further comprise a collimator lens and an objective lens.

The aforementioned light receiving element may comprise a main light receiving element and a plurality of sub-light receiving elements for detection of a tilt error.

The aforementioned plural sub-light receiving elements may comprise a plurality of tilt error detection sub-light receiving elements for detecting a tilt of the recording medium caused by a warp or the like and a plurality of tracking error detection sub-light receiving elements.

The aforementioned main light-receiving element may be divided into two regions and so be formed that the reflected ray of the main beam diffracted in the second diffraction region is focused onto the centre of the parting line.

Each of the aforementioned tilt error detection sub-light receiving elements may also be divided into two regions and be so formed that the reflected ray of the respective tilt error detection sub-beam diffracted in the second diffraction region is focused onto the centre of the parting line.

The aforementioned tracking error detection sub-light receiving elements may also have one light receiving region respectively and be so formed that the reflected rays of the tracking error detection sub-beams diffracted in the second diffraction region are focused thereon.

The aforementioned arithmetic circuit may comprise a subtraction circuit arranged so that a tilt error signal is obtained according to the output signal from the tilt error detection sub-light receiving element.

The aforementioned diffracting element may comprise at least a diffraction region for separating the tilt error detection sub-beam and a diffraction region for letting the tilt error detection sub-beam focus on a predetermined tilt error detection sub-light receiving element.

Claims

1. An optical pickup device for focusing an irradiating ray (A) from a light emitting element (1) on a recording medium (5) and letting a reflected ray (B) reflected by this recording medium focus on a light receiving element (6), the device comprising:

   a diffracting element (2) disposed before said light emitting element and said light re-

ceiving element;

at least a first diffraction region (2a) included in said diffracting element for separating said irradiating ray from said light emitting element into a main beam (A_0) and sub-beams (A_{+1a}, A_{-1a}) shifted from said main beam in a direction perpendicular to a track direction of a track of said recording medium where said main beam is focused:

a second diffraction region (2b) included in said diffracting element for directing a reflected ray (B_0) of said main beam reflected from said recording medium onto a main light receiving element (6a) and directing reflected rays (B_{+1a}, B_{-1a}) of said sub-beams onto sub-light receiving elements (6b, 6c); and

an arithmetic circuit (10) for detecting a tilt error signal showing the focusing condition of said sub-beams according to the output of said sub-light receiving elements (6b, 6c).

2. An optical pickup device according to claim 1, wherein said diffracting element (2) is divided into more than two diffraction regions (2a, 2b, 2c; 2a, $2b_1$, $2b_2$, $2b_3$, 2c, 2d).

3. An optical pickup device according to claim 2 wherein said diffracting element (2) is so formed that 0th-order diffraction efficiencies for the individual diffraction regions are substantially equal so that a distribution of the luminous intensity of the main beam is symmetrical.

4. An optical pickup device according to claim 2, wherein a region of said diffracting element (2) other than said second diffraction region (2b) is divided into said first diffraction region (2a) and a third diffraction region (2c).

5. An optical pickup device according to claim 4, wherein said first diffraction region (2a) is provided with a diffraction grating for separating the irradiating ray released from said light emitting element into a 0th-order diffracted ray (A_{0a}) and ± 1st-order diffracted rays (A_{+1a}, A_{-1a}).

6. An optical pickup device according to claim 4, wherein said third diffraction region (2c) is provided with a diffraction grating for separating the irradiating ray released from said light emitting element into a 0th-order diffracted ray (A_{0c}) and ± 1st-order diffracted rays (A_{+1c}, A_{-1c}) shifted back and forth from said 0th-order diffracted ray along a track direction of the recording medium.

7. An optical pickup device according to claim 4, wherein said second diffraction region (2b) is provided with the properties of a cylindrical lens.

8. An optical pickup device according to claim 1, further comprising a collimator lens (3) and an objective lens (4).

9. An optical pickup device according to claim 1, wherein said light receiving element (6) comprises a main light receiving element (6a) and a plurality of sub-light receiving elements (6b, 6c, 6d, 6e) for detecting at least a tilt error.

10. An optical pickup device according to claim 9, wherein said plurality of sub-light receiving elements (6b, 6c, 6d, 6e) comprise a plurality of tilt error detection sub-light receiving elements (6b, 6c) for detecting a local tilt of said recording medium and a plurality of tracking error detection sub-light receiving elements (6d, 6e).

11. An optical pickup device according to claim 9, wherein said main light receiving elements (6a) is divided into two regions and is so formed that the reflected ray (B_0) of said main beam diffracted in said second diffraction region is focused onto the centre of the parting line.

12. An optical pickup device according to claim 10, wherein each of said tilt error detection sub-light receiving elements (6b, 6c) is divided into two regions and is so formed that a reflected ray (B_{-1a}, B_{+1a}) of a respective tilt error detection sub-beam diffracted in said second diffraction region is focused onto the centre of the parting line.

13. An optical pickup device according to claim 10, wherein said tracking error detection sub-light receiving elements (6d, 6e) have one light receiving region respectively and are so formed that reflected rays (B_{-1c}, B_{+1c}) of respective tracking error detection sub-beams diffracted in said second diffraction region are focused thereon.

14. An optical pickup device according to claim 1, wherein said arithmetic circuit comprises a subtraction circuit (10) arranged so that a tilt error signal (TLE) is obtained according to the output signal from a said tilt error detection sub-light receiving element (6b, 6c).

15. An optical pickup device according to claim 1, wherein said arithmetic circuit comprises a signal detecting circuit composed of an addition

circuit (7) and a subtraction circuit (8).

16. An optical pickup device according to claim 1, wherein said diffracting element (2) comprises at least a diffraction region (2a) for separating said tilt error detection sub-beam and a diffraction region (2b) for letting said tilt error detection sub-beam focus on a predetermined tilt error detection sub-light receiving element.

17. An optical pickup device according to claim 1, wherein said diffracting element (2) is provided with the properties of a condensing lens for condensing a reflected ray or an irradiating ray.

18. An optical pickup device according to claim 4, wherein said diffracting element (2) comprises a fourth diffraction region (2d) for focusing the reflected ray of said main beam on said light receiving element (6f) to detect a reproduced information signal, said fourth diffraction region being provided between said first diffraction region (2a) for separating the tilt error detection sub-beam and said third diffraction region (2c), and wherein said second diffraction region, (2b) is divided into three diffraction regions ($2b_1$, $2b_2$, $2b_3$), each region for letting the reflected rays of said main beam, a tilt error detection sub-beam and a tracking error detection sub-beam respectively focus on individual light receiving elements (6a, 6b/c, 6d/e).

19. An optical pickup device for reading information formed in a track or tracks (5a) on an optical recording medium (5) by focusing light (A) from a light source (1) onto the medium and detecting light (B) reflected from the track, wherein a diffracting element (2) interposed between the light source and the medium forms a main beam (A_0) and sub-beams (A_{+1a}, A_{-1a}), shifted with respect to the main beam in a direction transverse to the track direction, and wherein a detector assembly (6) includes a main detector (6a) for receiving the reflected main beam (B_0) and sub-detectors (6b, 6c) spaced from the main detector in said transverse direction for receiving the reflected sub-beams (B_{+1a}, B_{-1a}), the reflected main beam and the reflected sub-beams being directed to the detector assembly by said diffracting element, means (10) being provided for deriving from the outputs of said sub-detectors a signal (TLE) representing tilt of the medium.

Patentansprüche

1. Optische Abtastvorrichtung zum Fokussieren eines Beleuchtungsstrahls (A) von einem Licht emittierenden Element (1) auf einen Aufzeichnungsträger (5) einerseits und des vom Aufzeichnungsträger reflektierten Strahls (B) auf ein Licht empfangendes Element (6) andererseits, wobei die Vorrichtung folgendes aufweist:
   - ein Beugungselement (2), das vor dem Licht emittierenden Element und dem Licht empfangenden Element angeordnet ist;
   - mindestens einen ersten Beugungsbereich (2a) im Beugungselement, um des Beleuchtungsstrahl vom Licht emittierenden Element in ein Hauptstrahlenbündel (A_0) und Unterstrahlenbündel (A_{+1a}, A_{-1a}) aufzuteilen, die gegenüber dem Hauptstrahlenbündel in einer Richtung rechtwinklig zur Spurrichtung einer Spur auf dem Aufzeichnungsträger, auf die das Hauptstrahlenbündel fokussiert wird, verschoben sind;
   - einen zweiten Beugungsbereich (2b) im Beugungselement zum Hinlenken eines reflektierten Strahls (B_0) des vom Aufzeichnungsträger reflektierten Hauptstrahlenbündels auf ein Haupt-Lichtempfangselement (6a) und zum Hinlenken reflektierter Strahlen (B_{+1a}, B_{-1a}) der Unterstrahlenbündel auf Unter-Lichtempfangselemente (6b, 6c); und
   - eine Arithmetikschaltung (10) zum Erfassen eines Neigungsfehlersignals, das den Fokussierzustand der Unterstrahlenbündel abhängig vom Ausgangssignal der Unter-Lichtempfangselemente (6b, 6c) zeigt.

2. Optische Abtastvorrichtung nach Anspruch 1, bei der das Beugungselement (2) in mehr als zwei Beugungsbereiche (2a, 2b, 2c; 2a, $2b_1$, $2b_2$, $2b_3$, 2c, 2d) unterteilt ist.

3. Optische Abtastvorrichtung nach Anspruch 2, bei der das Beugungselement (2) so ausgebildet ist, daß die Wirkungsgrade der einzelnen Beugungsbereiche für die Beugung 0-ter Ordnung im wesentlichen einander gleich sind, so daß die Leuchtstärkeverteilung des Hauptstrahlenbündels symmetrisch ist.

4. Optische Abtastvorrichtung nach Anspruch 2, bei der ein Bereich des Beugungselements (2) außer dem zweiten Beugungsbereich (2b) in den ersten Beugungsbereich (2a) und einen

dritten Beugungsbereich (2c) unterteilt ist.

5. Optische Abtastvorrichtung nach Anspruch 4, bei der der erste Beugungsbereich (2a) mit einem Beugungsgitter versehen ist, um den vom Licht emittierenden Element ausgegebenen Beleuchtungsstrahl in einen gebeugten Strahl 0-ter Ordnung (A_{0a}) und gebeugte Strahlen ±1-ter Ordnung (A_{+1a}, A_{-1a}) aufzuteilen.

6. Optische Abtastvorrichtung nach Anspruch 4, bei der der dritte Beugungsbereich (2c) mit einem Beugungsgitter versehen ist, um den vom Licht emittierenden Element ausgegebenen Beleuchtungsstrahl in einen gebeugten Strahl (A_{0c}) 0-ter Ordnung und gebeugte Strahlen ±1-ter Ordnung (A_{+1c}, A_{-1c}) aufzuteilen, die gegenüber dem gebeugten Strahl 0-ter Ordnung entlang der Spurrichtung auf dem Aufzeichnungsträger nach hinten und vorne verschoben sind.

7. Optische Abtastvorrichtung nach Anspruch 4, bei der der zweite Beugungsbereich (2b) mit den Eigenschaften einer Zylinderlinse versehen ist.

8. Optische Abtastvorrichtung nach Anspruch 1, die ferner eine Kollimatorlinse (3) und eine Objektivlinse (4) aufweist.

9. Optische Abtastvorrichtung nach Anspruch 1, bei der das Licht empfangende Element (6) ein Haupt-Lichtempfangselement (6a) und mehrere Unter-Lichtempfangselemente (6b, 6c, 6d, 6e) zum Erfassen mindestens eines Neigungsfehlers aufweist.

10. Optische Abtastvorrichtung nach Anspruch 9, bei der die mehreren Unter-Lichtempfangselemente (6b, 6c, 6d, 6e) mehrere Neigungsfehlererfassung-Unter-Lichtempfangselemente (6b, 6c) zum Erfassen einer örtlichen Neigung des Aufzeichnungsmediums sowie mehrere Spurahweichungserfassung-Unter-Lichtempfangselemente (6d, 6e) aufweist.

11. Optische Abtastvorrichtung nach Anspruch 9, bei der das Haupt-Lichtempfangselement (6a) in zwei Bereiche unterteilt ist und so ausgebildet ist, daß der reflektierte Strahl (B_0) des im zweiten Beugungsbereich gebeugten Hauptstrahlenbündels auf die Mitte der Unterteilungslinie fokussiert wird.

12. Optische Abtastvorrichtung nach Anspruch 10, bei der jedes der Neigungsfehlerabweichung-Unter-Lichtempfangselemente (6b, 6c) in zwei Bereiche unterteilt ist und so ausgebildet ist, daß ein reflektierter Strahl (B_{-1a}, B_{+1a}) eines jeweiligen im zweiten Beugungsbereich gebeugten Neigungsabweichungserfassung-Unterstrahlenbündels auf die Mitte der Unterteilungslinie fokussiert wird.

13. Optische Abtastvorrichtung nach Anspruch 10, bei der die Spurabweichungserfassung-Unter-Lichtempfangselemente (6d, 6e) jeweils einen Lichtempfangsbereich aufweisen und so ausgebildet sind, daß reflektierte Strahlen (B_{-1c}, B_{+1c}) jeweiliger im zweiten Beugungsbereich gebeugter Spurabweichungserfassung-Unterstrahlenbündel darauf fokussiert werden.

14. Optische Abtastvorrichtung nach Anspruch 1, bei der die Arithmetikschaltung eine Subtraktionsschaltung (10) aufweist, die so ausgebildet ist, daß ein Neigungsfehlersignal (TLE) abhängig vom Ausgangssignal vom Neigungsfehlererfassung-Unter-Lichtempfangselement (6b, 6c) erhalten wird.

15. Optische Abtastvorrichtung nach Anspruch 1, bei der die Arithmetikschaltung eine Signalerfassungsschaltung aufweist, die aus einer Additionsschaltung (7) und einer Subtraktionsschaltung (8) besteht.

16. Optische Abtastvorrichtung nach Anspruch 1, bei der das Beugungselement (2) mindestens einen Beugungsbereich (2a) zum Aufteilen des Neigungsfehlererfassung-Unterstrahlenbündels und einen Beugungsbereich (2b) aufweist, der es ermöglicht, das Neigungsfehlererfassung-Unterstrahlenbündel auf ein vorgegehenes Neigungsfehlererfassung-Unter-Lichtempfangselement zu fokussieren.

17. Optische Abtastvorrichtung nach Anspruch 1, bei der das Beugungselement (2) mit den Eigenschaften einer Kondensorlinse versehen ist, um einen reflektierten Strahl oder einen Beleuchtungsstrahl zu bündeln.

18. Optische Abtastvorrichtung nach Anspruch 4, bei der das Beugungselement (2) einen vierten Beugungsbereich (2d) aufweist, um den reflektierten Strahl des Hauptstrahlenbündels auf das Licht empfangende Element (6f) zu fokussieren, um ein Signal für wiedergegebene Information zu erfassen, wobei der vierte Beugungsbereich zwischen dem ersten Beugungsbereich (2a) zum Aufteilen des Neigungsfehlerabweichung-Unterstrahlenhündels und dem dritten Beugungsbereich (2c) angeordnet ist, und bei dem der zweite Beugungsbereich (2b)

in drei Beugungsbereiche ($2b_1$, $2b_2$, $2b_3$) unterteilt ist, wobei es jeder Bereich ermöglicht, die reflektierten Strahlen des Hauptstrahlenbündels, eines Neigungsfehlerabweichung-Unterstrahlenbündels und eines Spurabweichungserfassung-Unterstrahlenbündels jeweils auf einzelne Licht empfangende Elemente (6a, 6b/c, 6d/e) zu fokussieren.

19. Optische Abtastvorrichtung zum Lesen von Information, die in einer Spur oder Spuren (5a) auf einem optischen Aufzeichnungsträger (5) ausgebildet ist, durch Fokussieren von Licht (A) von einer Lichtquelle (1) auf den Träger und durch Erfassen von von der Spur reflektierten Lichts (B), bei der ein zwischen die Lichtquelle und den Träger eingefügtes Beugungselement (2) ein Hauptstrahlenbündel (A_0) und Unterstrahlenbündel (A_{+1a}, A_{-1a}) bildet, die in bezug auf das Hauptstrahlenbündel in einer Richtung quer zur Spurrichtung verschoben sind, und bei der eine Detektoranordnung (6) einen Hauptdetektor (6a) zum Empfangen des reflektierten Hauptstrahlenbündels (B_0) und Unterdetektoren (6b, 6c) aufweist, die vom Hauptdetektor in der besagten Querrichtung beabstandet sind, um die reflektierten Unterstrahlenbündel (B_{+1a}, B_{-1a}) zu empfangen, wobei das reflektierte Hauptstrahlenbündel und die reflektierten Unterstrahlenbündel durch das Beugungselement auf die Detektoranordnung gerichtet werden, wobei Einrichtungen (10) vorhanden sind, um aus den Ausgangssignalen der Unterdetektoren ein Signal (TLE) abzuleiten, das die Neigung des Trägers repräsentiert.

Revendications

1. Dispositif de lecture optique pour focaliser un rayon (A) émis par un élément émetteur de lumière (1) sur un support d'enregistrement (5) et permettre à un rayon réfléchi (B) réfléchi par ce support d'enregistrement de se focaliser sur un élément récepteur de lumière (6), ce dispositif comprenant :

   un élément diffracteur (2) placé devant ledit élément émetteur de lumière et ledit élément récepteur de lumière ;

   au moins une première région de diffraction (2a) comprise dans ledit élément diffracteur pour séparer ledit rayon émis par ledit élément émetteur de lumière en un faisceau principal (A_0) et des faisceaux secondaires (A_{+1a}, A_{-1a}) décalés par rapport au dit faisceau principal suivant une direction perpendiculaire àune direction de piste d'une piste dudit support d'enregistrement où ledit faisceau principal est focalisé ;

   une deuxième région de diffraction (2b) comprise dans ledit élément diffracteur pour diriger un rayon réfléchi (B_0) dudit faisceau principal, réfléchi par ledit support d'enregistrement sur un élément principal récepteur de lumière (6a), et pour diriger les rayons réfléchis (B_{+1a}, B_{-1a}) desdits faisceaux secondaires sur des éléments récepteurs secondaires de lumière (6b, 6c) ; et

   un circuit arithmétique (10) pour détecter un signal d'erreur d'inclinaison montrant l'état de focalisation desdits faisceaux secondaires en fonction des signaux de sortie desdits éléments récepteurs secondaires de lumière (6b, 6c).

2. Dispositif de lecture optique suivant la revendication 1, dans lequel ledit élément diffracteur (2) est divisé en plus de deux régions de diffraction (2a, 2b, 2c ; 2a, $2b_1$, $2b_2$, $2b_3$, 2c, 2d).

3. Dispositif de lecture optique suivant la revendication 2, dans lequel ledit élément diffracteur (2) est formé de telle façon que des efficacités de diffraction d'ordre zéro pour les régions de diffraction individuelles soient sensiblement égales, de sorte qu'une répartition de l'intensité lumineuse du faisceau principal est symétrique.

4. Dispositif de lecture optique suivant la revendication 2, dans lequel une région dudit élément diffracteur (2) autre que ladite deuxième région de diffraction (2b) est divisée en ladite première région de diffraction (2a) et une troisième région de diffraction (2c).

5. Dispositif de lecture optique suivant la revendication 4, dans lequel ladite première région de diffraction (2a) est pourvue d'un réseau de diffraction pour séparer le rayon émis par ledit élément émetteur de lumière en un rayon diffracté de diffraction d'ordre zéro (A_{0a}) et des rayons diffractés de diffraction de ± 1er ordre (A_{+1a}, A_{-1a}).

6. Dispositif de lecture optique suivant la revendication 4, dans lequel ladite troisième région de diffraction (2c) est pourvue d'un réseau de diffraction pour séparer le rayon émis par ledit élément émetteur de lumière en un rayon diffracté de diffraction d'ordre zéro (A_{0c}) et des rayons diffractés de diffraction de ± 1er ordre (A_{+1c}, A_{-1c}) décalés en avant et en arrière par rapport au dit rayon diffracté de diffraction d'ordre zéro, suivant une direction de piste du

support d'enregistrement.

7. Dispositif de lecture optique suivant la revendication 4, dans lequel ladite deuxième région de diffraction (2b) est pourvue des propriétés d'une lentille cylindrique.

8. Dispositif de lecture optique suivant la revendication 1, comprenant en outre une lentille collimatrice (3) et une lentille d'objectif (4).

9. Dispositif de lecture optique suivant la revendication 1, dans lequel ledit élément récepteur de lumière (6) comprend un élément récepteur principal de lumière (6a), et plusieurs éléments récepteurs secondaires de lumière (6b, 6c, 6d, 6e) pour détecter au moins une erreur d'inclinaison.

10. Dispositif de lecture optique suivant la revendication 9, dans lequel lesdits éléments secondaires récepteurs de lumière (6b, 6c, 6d, 6e) comprennent plusieurs éléments récepteurs secondaires de lumière pour la détection d'erreur d'inclinaison (6b, 6c) pour détecter une inclinaison locale dudit support d'enregistrement, et plusieurs éléments récepteurs secondaires de lumière pour la détection d'erreur de piste (6d, 6e).

11. Dispositif de lecture optique suivant la revendication 9, dans lequel ledit élément récepteur de lumière principal (6a) est divisé en deux régions, et est formé de telle sorte que le rayon réfléchi (B_0) dudit faisceau principal diffracté dans ladite deuxième région de diffraction soit focalisé sur le centre de la ligne de séparation.

12. Dispositif de lecture optique suivant la revendication 10, dans lequel chacun desdits éléments récepteurs secondaires de lumière pour la détection d'erreur d'inclinaison (6b, 6c) est divisé en deux régions et est formé de telle sorte qu'un rayon réfléchi (B_{-1a}, B_{+1a}) d'un faisceau secondaire respectif diffracté dans ladite deuxième région de diffraction soit focalisé sur le centre de la ligne de séparation.

13. Dispositif de lecture optique suivant la revendication 10, dans lequel lesdits éléments récepteurs secondaires de lumière pour la détection d'erreur de piste (6d, 6e) ont respectivement une région réceptrice de lumière et sont formés de telle sorte que les rayons réfléchis (B_{-1c}, B_{+1c}) des faisceaux secondaires respectifs pour la détection d'erreur de piste, diffractés dans ladite deuxième région de diffraction, soient focalisés sur cette dernière.

14. Dispositif de lecture optique suivant la revendication 1, dans lequel ledit circuit arithmétique comprend un circuit de soustraction (10) disposé de telle sorte qu'un signal d'erreur d'inclinaison (TLE) est obtenu en fonction du signal de sortie provenant d'un dit élément récepteur secondaire de lumière pour la détection d'erreur d'inclinaison (6b, 6c).

15. Dispositif de lecture optique suivant la revendication 1, dans lequel ledit circuit arithmétique comprend un circuit de détection de signal composé d'un circuit d'addition (7) et un circuit de soustraction (8).

16. Dispositif de lecture optique suivant la revendication 1, dans lequel ledit élément diffracteur (2) comprend au moins une région de diffraction (2a) pour séparer ledit faisceau secondaire de détection d'erreur d'inclinaison et une région de diffraction (2b) pour permettre au dit faisceau secondaire de détection d'erreur d'inclinaison de se focaliser sur un élément récepteur secondaire de lumière pour la détection d'erreur d'inclinaison, cet élément étant prédéterminé.

17. Dispositif de lecture optique suivant la revendication 1, dans lequel ledit élément diffracteur (2) est pourvu des propriétés d'une lentille condensatrice pour condenser un rayon réfléchi ou un rayon émis.

18. Dispositif de lecture optique suivant la revendication 4, dans lequel ledit élément diffracteur (2) comprend une quatrième région de diffraction (2d) pour focaliser le rayon réfléchi dudit faisceau principal sur ledit élément récepteur de lumière (6f) pour détecter un signal d'information reproduit, ladite quatrième région de diffraction se trouvant entre ladite première région de diffraction (2a) pour séparer le faisceau secondaire de détection d'erreur d'inclinaison et ladite troisième région de diffraction (2c), et dans lequel ladite deuxième région de diffraction (2b) est divisée en trois régions de diffraction ($2b_1$, $2b_2$, $2b_3$), chaque région devant permettre aux rayons réfléchis dudit faisceau principal, d'un faisceau secondaire de détection d'erreur d'inclinaison et d'un faisceau secondaire de détection d'erreur de piste, de se focaliser respectivement sur les éléments récepteurs de lumière individuels (6a, 6b/c, 6d/e).

19. Dispositif de lecture optique pour lire des informations formées sur une piste ou des pistes (5a) d'un support d'enregistrement optique (5) en focalisant la lumière (A) provenant d'une source lumineuse (1) sur le support et en détectant la lumière (B) réfléchie par la piste, dans lequel un élément diffracteur (2) interposé entre la source lumineuse et le support forme un faisceau principal (A_0) et des faisceaux secondaires (A_{+1a}, A_{-1a}), décalés par rapport au faisceau principal suivant une direction transversale à la direction de piste et dans lequel un ensemble détecteur (6) inclut un détecteur principal (6a) pour recevoir le faisceau principal réfléchi (B_0) et des détecteurs secondaires (6b, 6c) espacés par rapport au détecteur principal suivant ladite direction transversale pour recevoir les faisceaux secondaires réfléchis (B_{+1a}, B_{-1a}), le faisceau principal réfléchi et les faisceaux secondaires réfléchis étant dirigés vers l'ensemble détecteur par ledit élément diffracteur, un moyen (10) étant prévu pour dériver des résultats desdits détecteurs secondaires un signal (TLE) représentant l'inclinaison du support.

FIG. 1

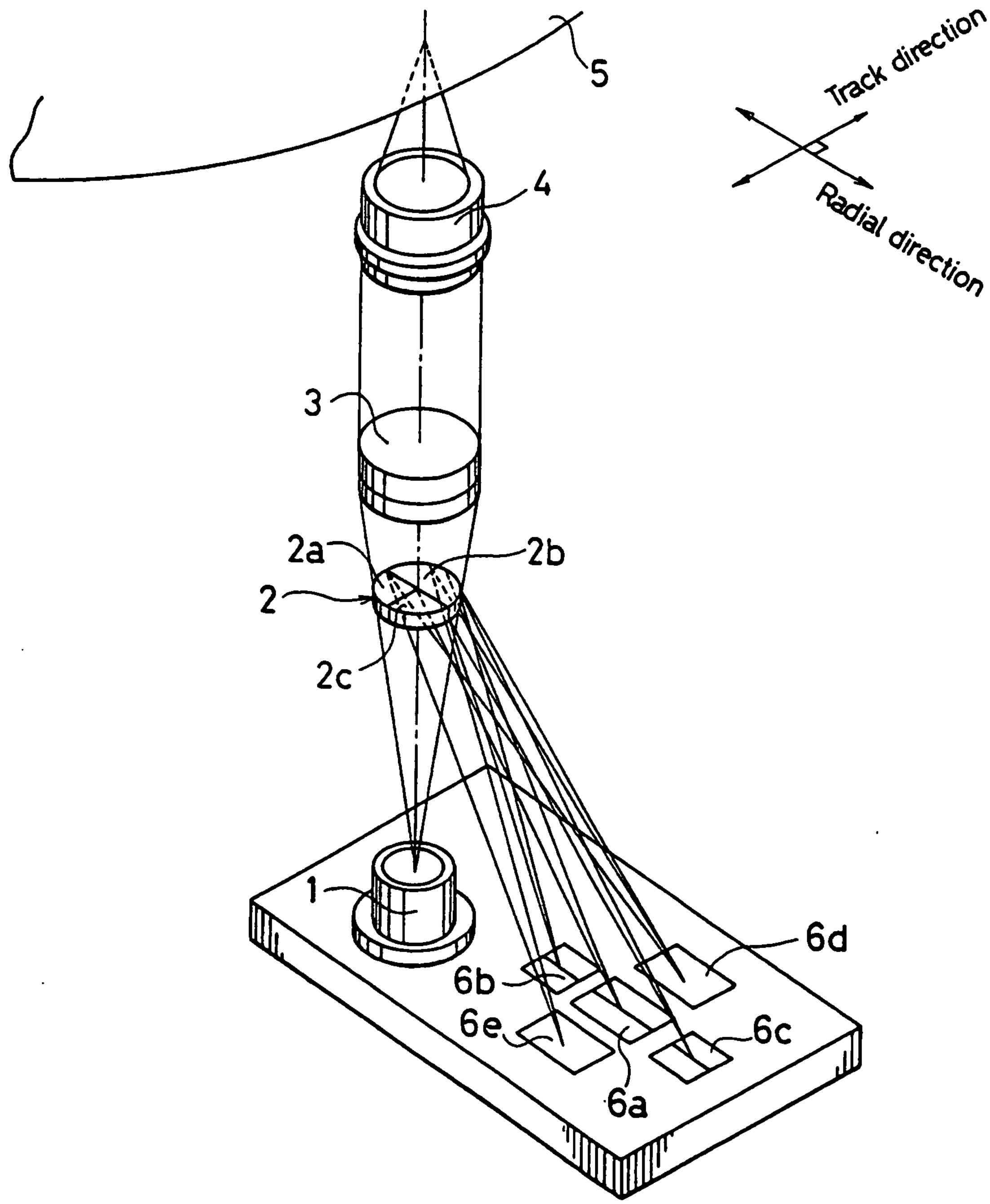

5
Track direction
Radial direction
4
3
2a
2b
2
2c
1
6d
6b
6e
6c
6a

FIG. 2 (a)

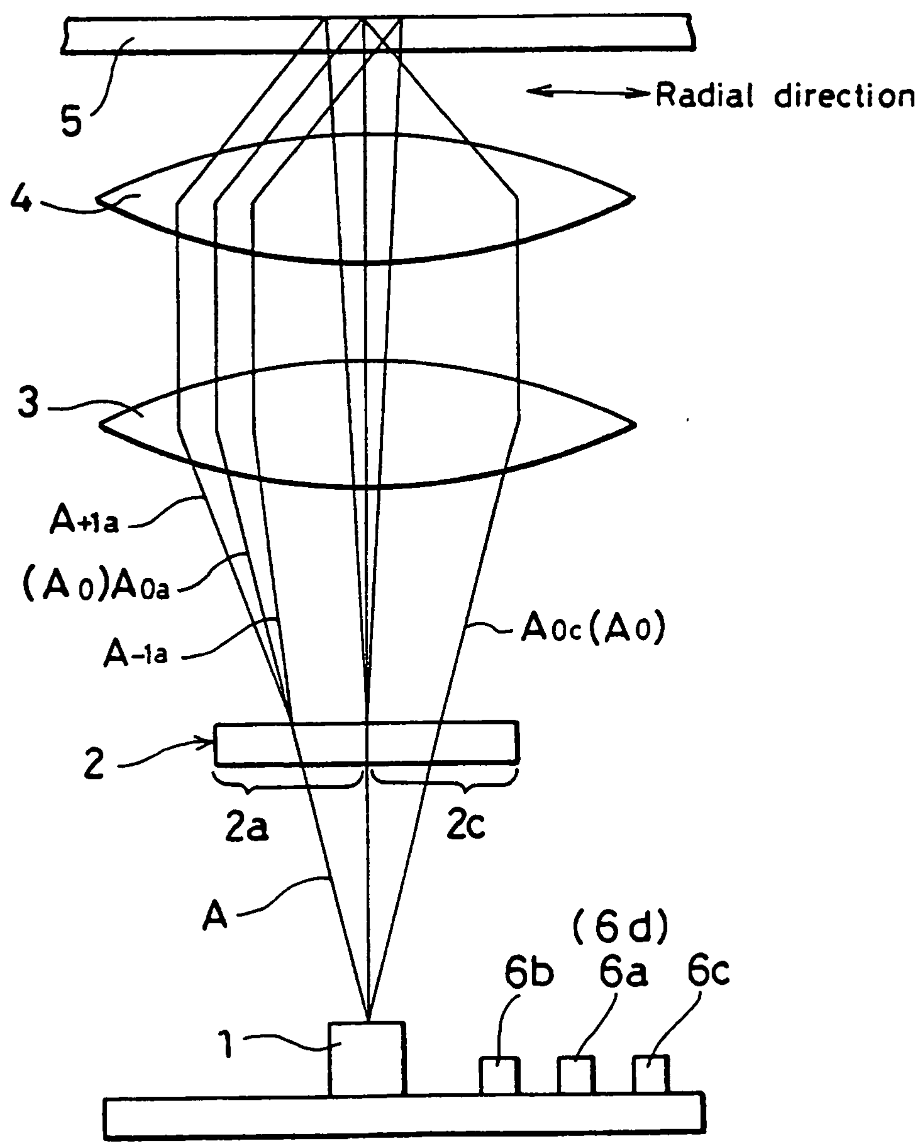


FIG.2(b)

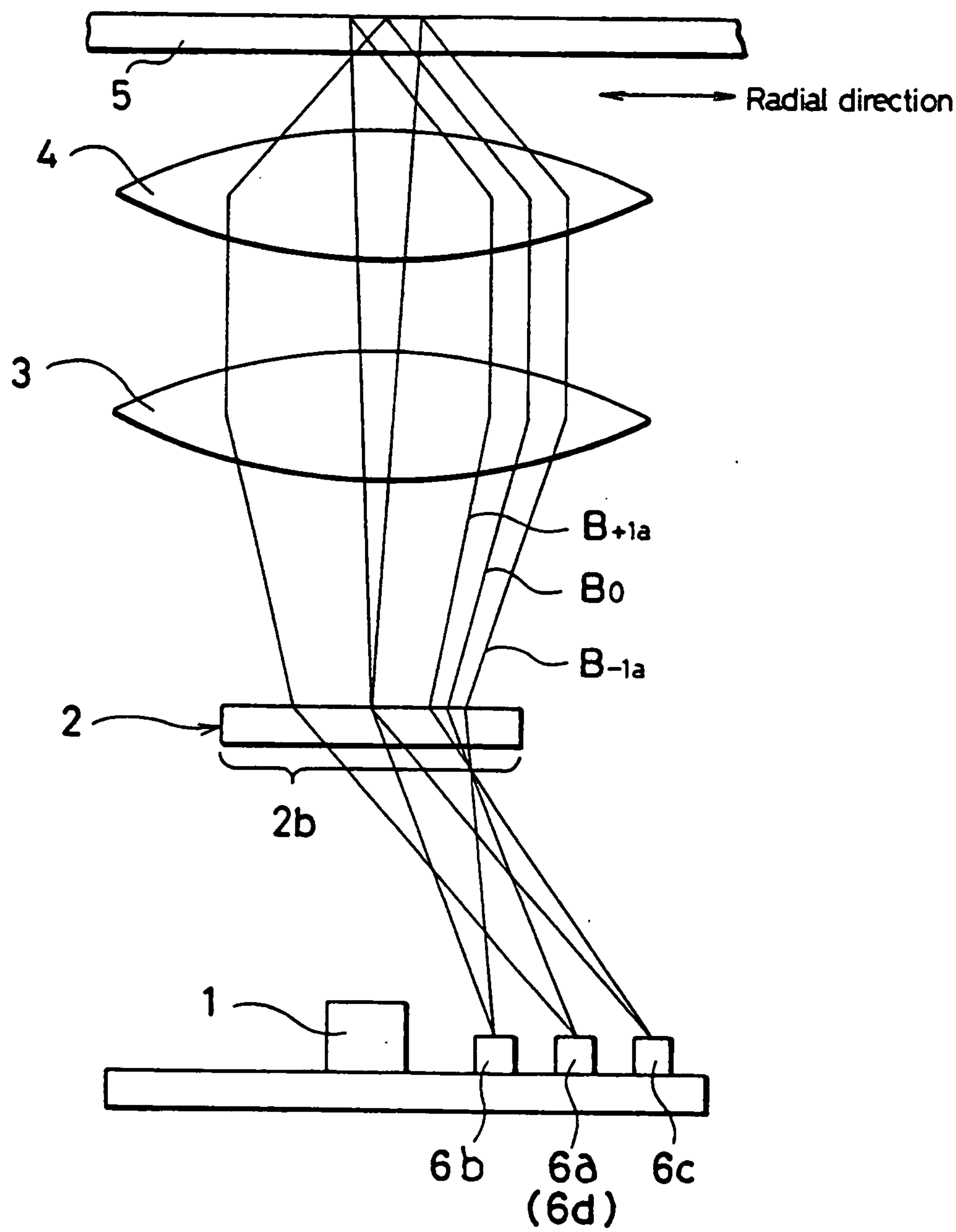


FIG.3 (a)

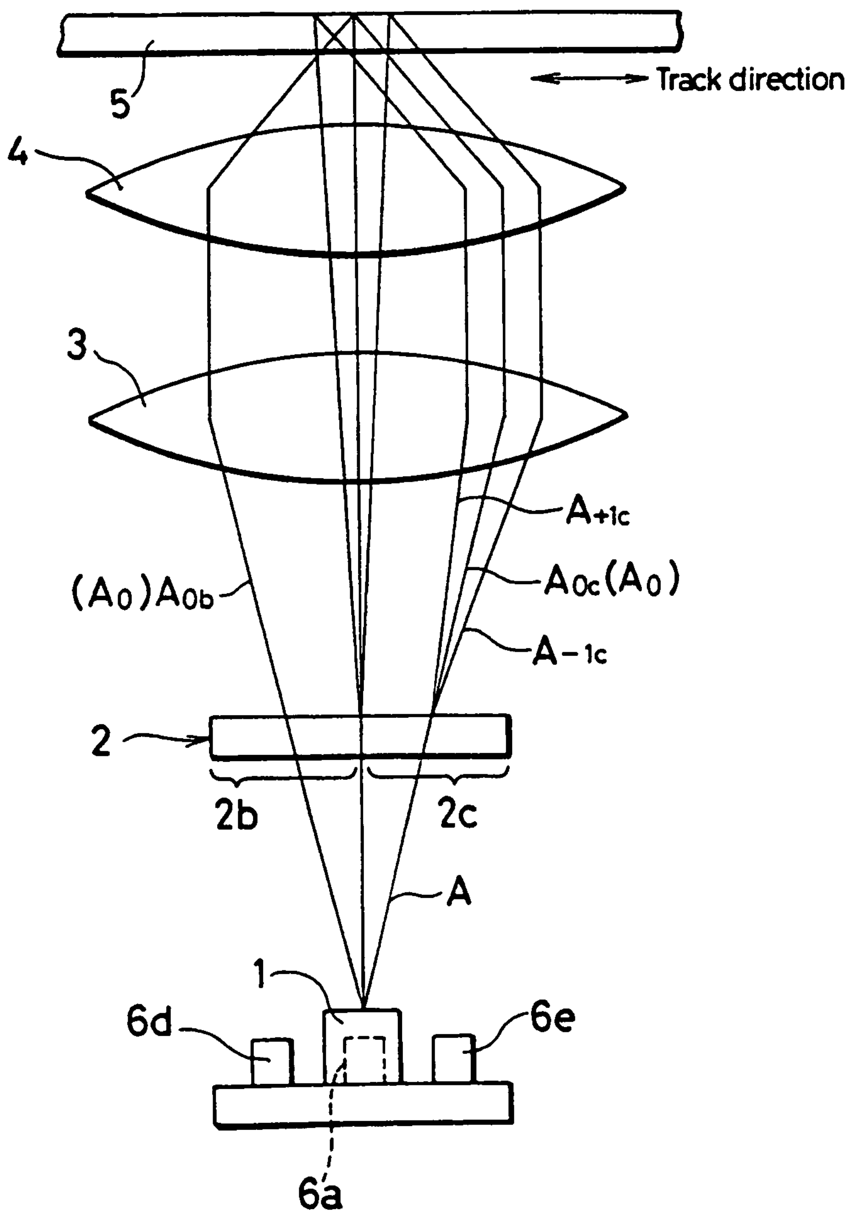
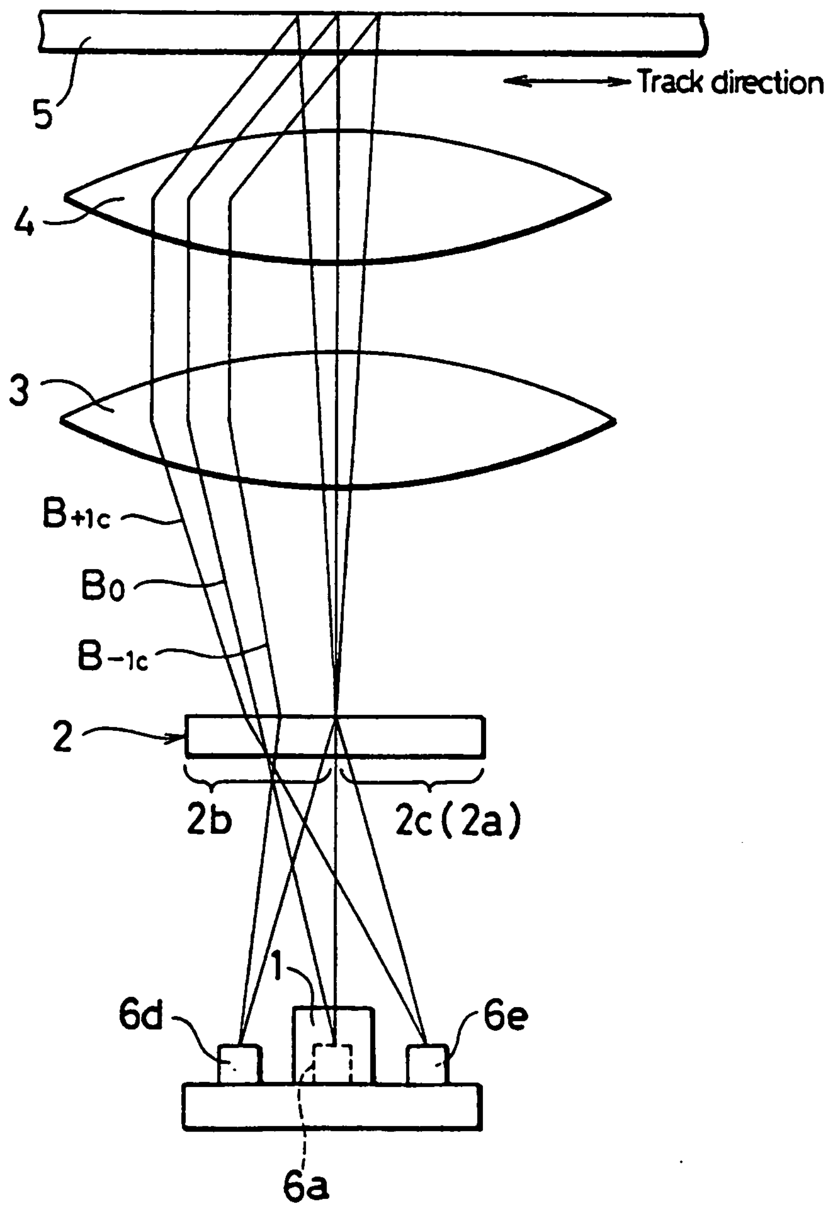


FIG. 3 (b)



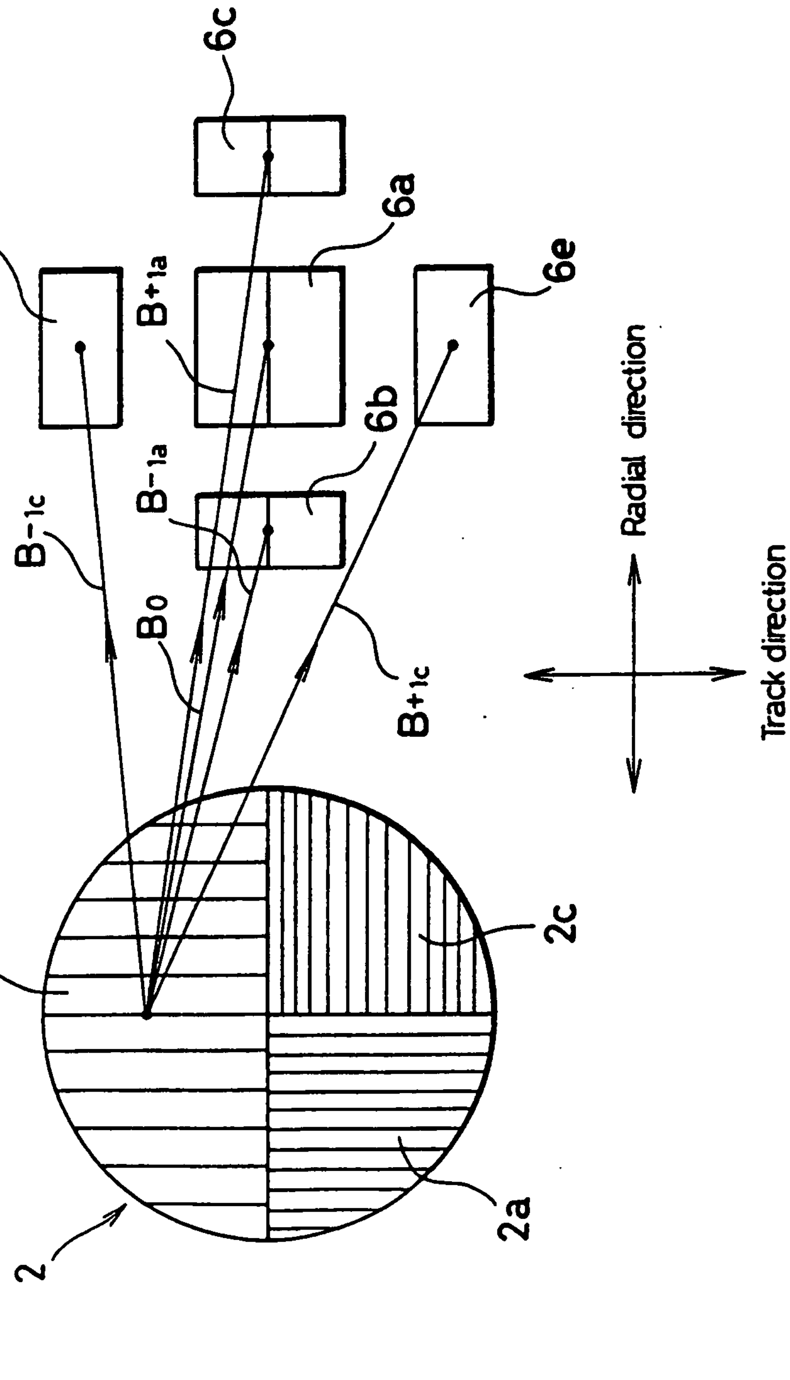

6c
6d
6a
6e
6b
B+1a
B-1a
B-1c
B0
B+1c
Radial direction
Track direction
2b
2c
2a
2

FIG. 4

FIG. 5

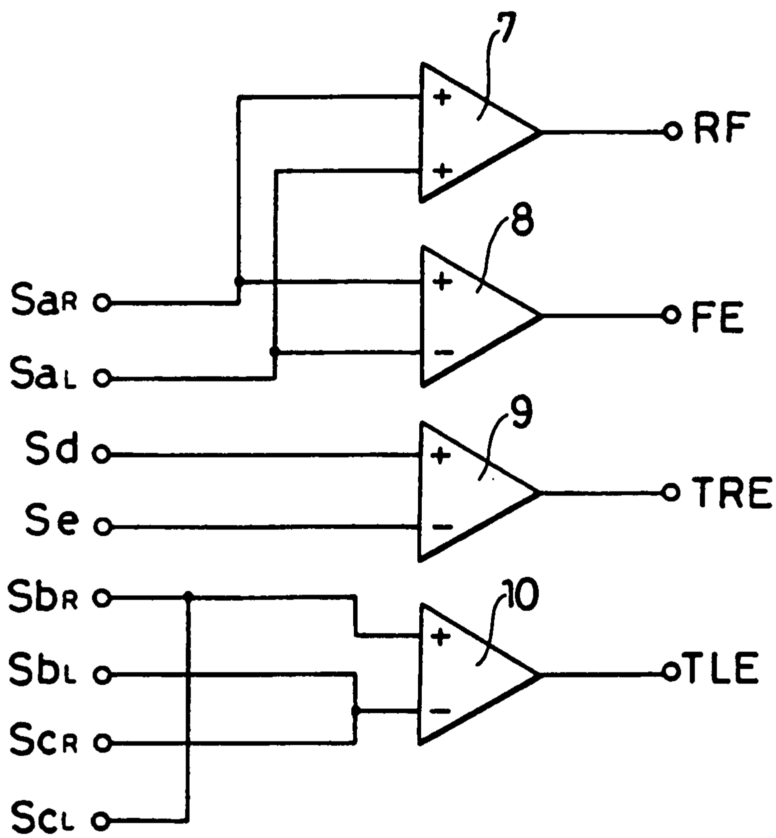
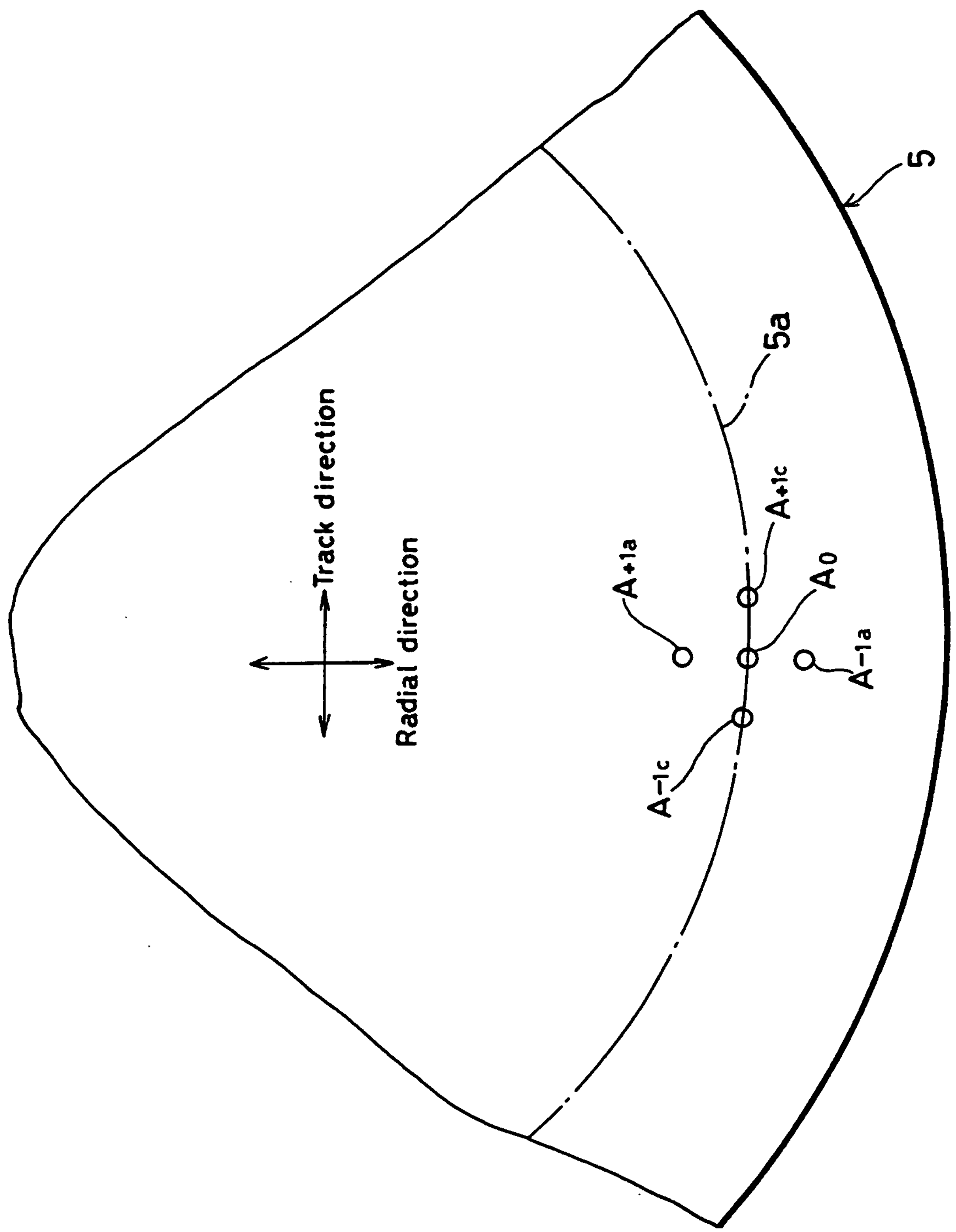


FIG. 6



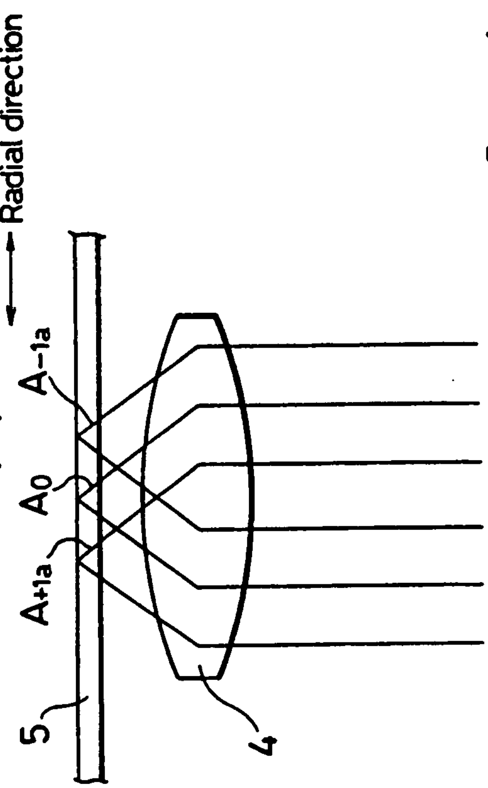


FIG. 7 (a)

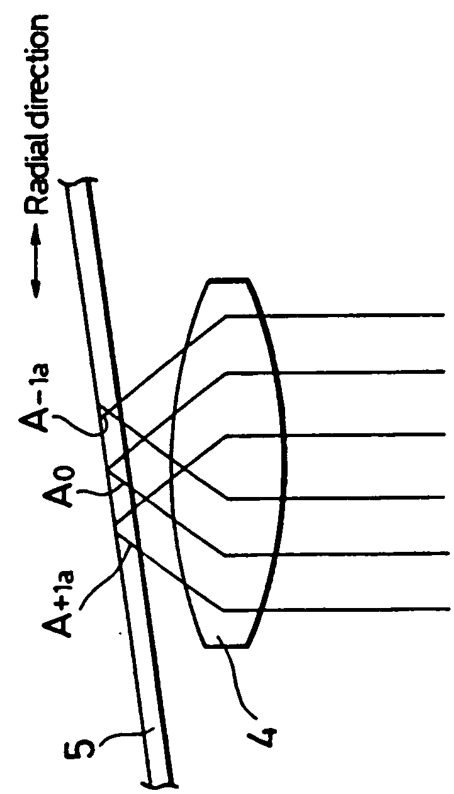


FIG. 7 (b)

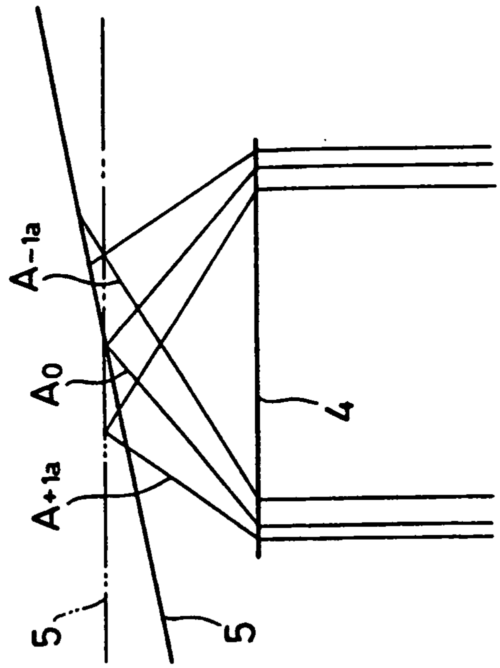


FIG. 8

FIG. 9

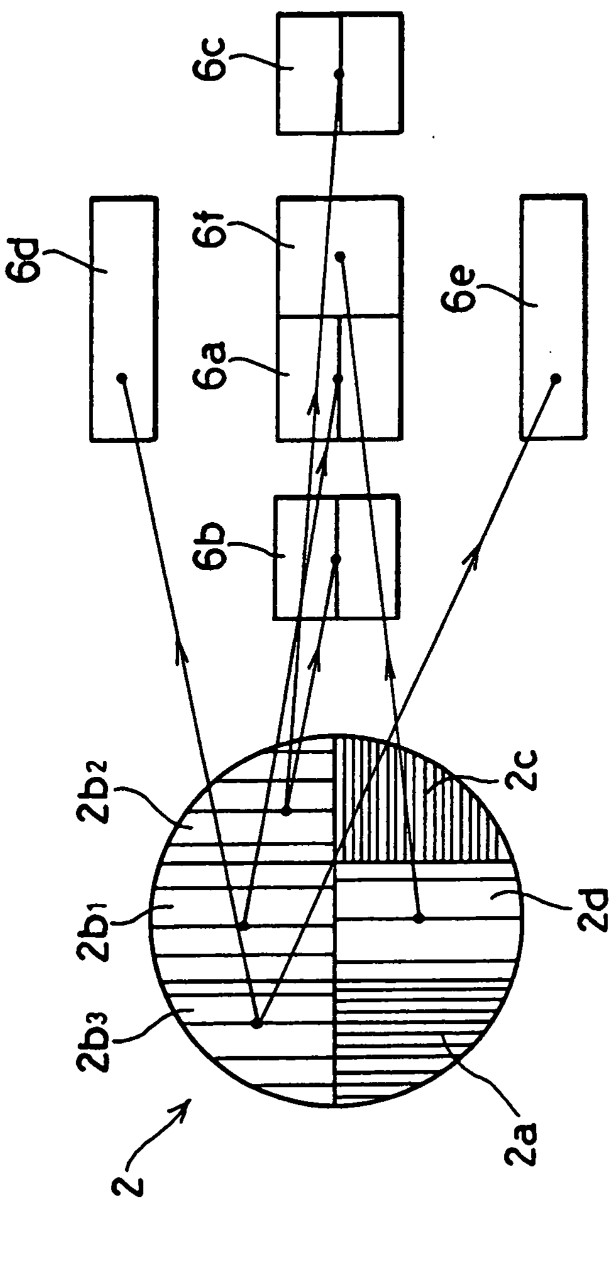


FIG. 10

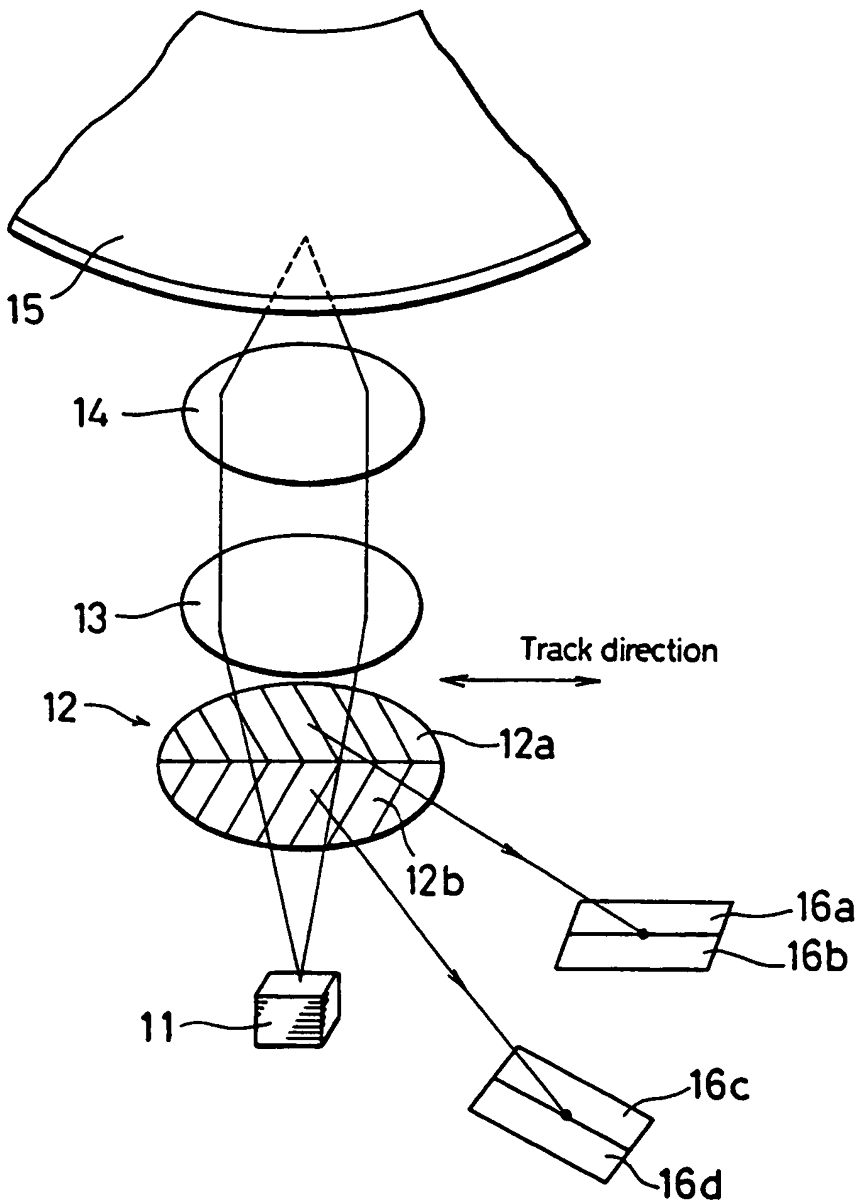


FIG.11

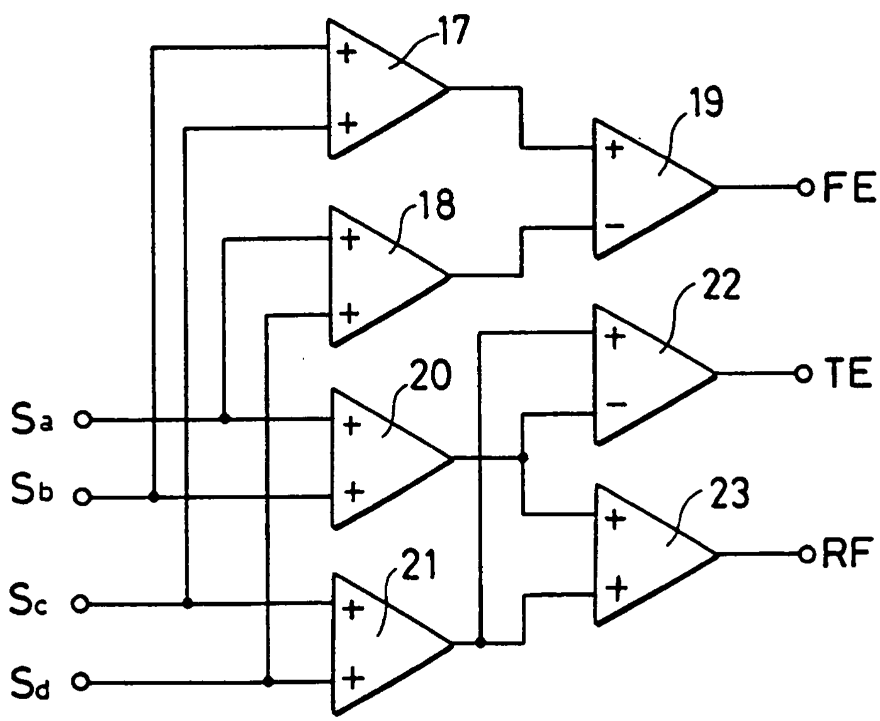


FIG.12(a)

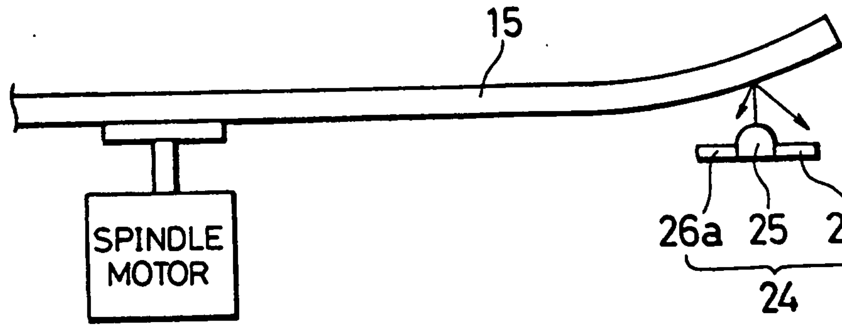


FIG.12(b)

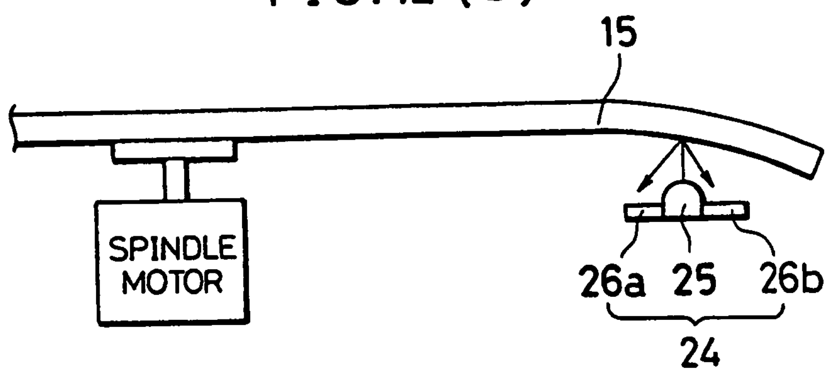


FIG.13